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ABSTRACT

Three conjunctive concept-learning problems were presented to 70 educable mentally retarded (EMR) children (9 to 14 years old) and 76 controls (7 to 10 years old) to assess the effects of four verbalization conditions and the presence or absence of a memory aid on concept attainment. Verbalization conditions were the following. (1) no verbalization (performance condition), (2) verbalization following selection of a positive exemplar (positive condition), (3) verbalization following selection of a negative exemplar (negative condition), and (4) verbalization following every selection (total verbalization condition). Multivariate tests of the main effects indicated no differences in the rate of concept learning between EMR Ss and controls and no difference in performance as a function of the kind and amount of verbalization elicited. Both EMR Ss and controls profited from the presence of a memory aid.

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THE EFFECTS OF VERBALIZATION AND THE PRESENCE OF A MEMORY AID ON
CONCEPT LEARNING IN EDUCABLE MENTALLY RETARDED CHILDREN

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The Effects of Verbalization and the Presence
of a Memory Aid on Concept Learning in
Educable Mentally Retarded Children

Goals and Objectives

Three areas of concern in the education of educable mentally retarded (EMR) children are their apparent deficiencies in conceptual ability (Blount, 1968), short-term memory (Ellis, 1970; Garrison, 1970; Spitz, 1966), and language skills (Sitko & Semmell, 1973).

Teachers are continually asking EMR children to verbalize in the classroom. Their assumption is that verbalization will aid in the children's ability to conceptualize, and thus, will facilitate learning. There is, however, evidence in the research literature that this may not be the case. Few findings exist which can aid the teacher in knowing when it is beneficial to ask a child to verbalize in a conceptual learning task. Also, although much attention has been given to the memory deficit in the EMR, few studies have examined potential teaching intervention strategies which might facilitate memory processing. Teachers are currently using various forms of memory aids to reduce task complexity (e.g., multiplication matrices) without knowing the effectiveness of such aids.

The goals of the present study, therefore, were to determine (a) whether the availability of a memory aid actually facilitates learning, (b) how children respond when different verbalization conditions are manipulated in a concept learning task, and (c) whether changing the conditions of the learning situation affects the strategy (approach) a child uses in problem solution. A secondary objective was to explore the interaction of the verbalization and memory conditions.

The following hypotheses were, therefore, tested:

1. There would be no difference in the rate of concept learning between normal and EMR children since mental age was controlled.
2. There would be a difference in the rate of concept learning depending on the verbal condition for both normal and EMR children:
 - a. When only performance was measured (no verbalization), fewer trials to solution would be required than in any verbal condition.
 - b. Verbalization following a correct response would require fewer trials to solution than verbalization following an incorrect response.
3. Both normal and EMR children would perform better when a memory aid was present.

If substantiated, these hypotheses could readily be translated into actual teaching practices which would help to assure that more EMR children receive an appropriately designed education. Teachers could be sensitized to the judicious use of verbalization with EMRs. We would know better whether a child should be asked to verbalize when he has made an error or when he had attained a correct solution. It might be that in a given case, verbalization would impede performance and, therefore, should not be used (especially if our primary interest is in the attainment of the concept and not in the verbalization per se). In addition, if found helpful, a memory aid could be used quite easily by most teachers. Such findings would be very important since the largest percentage of retarded fall within the educable category (Robinson & Robinson, 1970). Educators must try to develop new ways of reaching this population, since traditional techniques have not been entirely successful (Iano, 1971; Mann & Phillips, 1967).

Dissemination of research findings have taken various forms including:

- (a) submission of an article for publication in a professional journal,
- (b) presentation of a paper to the national meeting of the Council for Exceptional Children, (c) dissemination of such findings through the course work in teacher-training programs at New York University, (d) informing teachers in the field via in-service training (seminars, etc.), (e) inclusion of the final report in the information disseminated by the Teaching Performance Center at New York University.

Historical Background Leading to Present Investigation

School learning is predominantly conceptual in nature (Gagne, 1965). Differences in quality of problem solving have traditionally been attributed either to motivational variables or adequacy of conceptual skills. Information processing variables, however, which indicate how learning occurs are also important in education. They influence the assessment of abilities, contribute to variability in achievement beyond that predicted by traditional ability and aptitude tests, and interact with variables of instruction (Lesser, 1971).

In an attempt to discover the processes underlying cognition in the educable mentally retarded, several investigators (Keogh, Wetter, McGinty, & Donlon, 1973; Witkin, Faterson, Goodenough, & Birnbaum, 1966) have turned to the systematic study of styles of information processing. Wyne, Coop, and Brookhouse (1970), for example, have shown that EMRs can attend to the discrete parts of a picture-arrangement test, but have difficulty processing the information. When nonperceptual conceptualizations based on the stimuli were required, EMRs could not see how the pieces fit together. Clark and Thompson (1963) found that with an easy task EMR children and adults function on a perceptual level by stating relationships as similarities among the physical items or by merely naming the items. The authors concluded that

easy tasks did not demand of the retardates that they consider nonrepresentational relationships between items. Harder tasks, on the other hand, demanded hierarchical groupings before the relationships became clear.

Three conjunctive concept-learning problems in which the perceptual stimuli were transformed from trial to trial were, therefore, chosen for use in this study. If "one square," for example, were the conjunctive concept to be identified, the subject had to understand the relationship between a large red square with two borders, a small blue square with one border, and so-on, as these instances were identified as exemplars of the concept on succeeding trials. Even if "oneness" and "squareness" were identified as relevant attributes, the relation between them also had to be discovered: neither attribute alone satisfied the requirements of the problem. Previous research (Reid, 1974) indicated that EMR children were capable of reaching a solution.

Since concept-learning problems require that complete information about the concept to be identified be spread over a series of trials, memory for previous information must play an important part in the attainment of concepts (Bourne & Dominowski, 1972). Concept attainment requires not that the subject remember all information about instances he has previously seen, but that he remember a subset of the stimulus input. "Any task in which the subject is required to map more than one stimulus point into a single response is a reduction task. The loss of information in these tasks clearly does not represent error, but rather is necessary to produce the required output" (Posner, 1965, p. 198).

It might seem that leaving all prior instances in view (Cahill & Hovland, 1960) would assist the limited memory of the EMR child (Ellis, 1970; Garrison, 1970; Spitz, 1966). Huttenlocher (1964), however, cites evidence

that such a procedure is too disturbing for the child with a limited memory span and poorly developed symbolic processes. Normal (McCarthy, 1968) and reflective EMR boys' performance (Reid, 1974) on nonverbal concept-attainment problems were improved with the presence of a single past instance. It was, therefore, anticipated that both normal and EMR children would perform better when a memory aid was present.

Milgrim and Furth (1967) and Furth (1963) point out that verbalization of a concept is neither a prerequisite to attainment of a concept nor to its continuing application. Piaget (1970) explains that learning on a behavioral level precedes learning at a representational, verbal level. Several studies (Milgrim, 1966; Milgrim & Furth, 1963; Prehm, 1966; Stephens, 1966a, 1966b, 1968) have found that retardates were able to solve conceptual problems more efficiently when solution did not require verbal description. Blount (1968), in reviewing concept-usage studies of the sorting type with familial retardates, concluded that the retarded appear to have concepts available to them and to use them as well as the mental age (MA) controls, but have difficulty verbalizing these same concepts.

The discrepancy between behavioral and verbal attainment of concepts in EMRs has frequently been explained in terms of Luria's (1961, 1963) theory of a verbal-mediation deficit in the retarded. As Milgrim (1971) notes: "According to Luria, increasing coordination of the two systems (motor and verbal) and the regulation of the motor system by the verbal system are age-related, are developmentally impaired in retarded subjects, and are presumed to account for the failure of retarded subjects to develop higher cognitive processes." While the studies of O'Connor and Hermelin (1959), Milgrim & Furth (1963), and Luria's own work provide questionable support for Luria's views (Zigler, 1966), the works of others provide no support or

even give contrary data (Balla & Zigler, 1964; Plenderleith, 1956; Reiber, 1964; Stevenson & Zigler, 1957). Klugh and Janssen (1966), and Reid (1974), for example, found that when retardates were asked to verbalize the rule they were using in conceptual tasks, if that rule were incorrect, they began making errors which indicated that their behavior was guided by their own false verbalizations. This is in direct contradiction to Luria's hypothesis that motor and verbal systems are dissociated in the retarded. It also leads to the notion that if an EMR child verbalizes a correct response, his concept learning will be facilitated. If, on the other hand, these children verbalize incorrectly, their concept learning should be impeded.

In a recent paper, moreover, Bronckart (1973) presented a considerable amount of evidence which questions Luria's hypothesis that behavior is regulated by speech in children. This evidence suggests that (a) in the majority of cases, tasks are not less well done in the silent than in the verbal condition, (b) adding a verbal response increases task complexity in that two forms of behavior are required in response to one stimulus, and (c) "the existence of a particular rule . . . in no way implies the possibility of verbalizing it, just as verbalization does not necessarily imply existence of an internalized rule" (p. 436). Thus, in accordance with Bronckart's findings, concept learning for both normal and EMR children should require fewer trials to solution when performance (without verbalization) is measured.

Traditionally children's performance on concept-attainment problems has been measured by estimates of over-all performance (Bourne, 1966). Such an approach, however, provides little or no detailed information as to how the child attains solution (Bourne, 1965, 1966).

It is the distinction between the superficial content of tasks, that is,

the right or wrong answer, and the processes that give rise to content which has escaped most workers in the field of mental retardation (Zigler, 1966). Since the subject's overt responses are related systematically to and indicative of his method of problem solving, an analysis of strategies is useful in describing more precise characteristics of performance (Olson, 1966). A modification of Laughlin's (1966) method of scoring untenable hypotheses, adapted for the analysis of children's strategies by McCarthy (1968), will be used. Both perceptual-inference (presence of a memory aid) and memory (absence of a memory aid) errors were examined. Untenable hypotheses will be defined as those which (a) include the opposite of any value on the previous trial or (b) repeat the entire hypothesis on a previous negative trial.

Staffing

Responsibility for carrying out the research was undertaken by the student investigator, Liora Schmelkin, under the supervision of Professor D. Kim Reid, the principal investigator. The authors are grateful for the assistance of Professor Elazar Pedhazur of New York University and of Professor Jeanette Gallagher of Temple University. Professor Pedhazur advised us on methodological issues. Professor Gallagher allowed us to use the concept attainment tests she devised. Ms. Sherry Roberts and Ms. Harriette Kendler were of invaluable assistance in the testing and transcription phases of this study.

Method

Design and Subjects

Seventy EMR and a control group of 76 normal children from four New York City public elementary schools were randomly assigned to the treatment conditions. The chronological ages of the EMR subjects ranged from 107 months to 175 months with a mean of 138.45 (S.D. = 14.55). The normal control group

was drawn from third-grade classes in the same schools with their chronological ages ranging from 88 months to 123 months with a mean of 107.10 ($S.D. = 3.46$). A listing of subjects by school is presented in Table 1. Children with reported emotional disturbance, neurological impairment, or physical defects were eliminated from the study.

Insert Table 1 about here

There were 16 treatment conditions consisting of eight conditions for each of the population samples (EMR and normal): four verbalization conditions by two memory aid conditions.

The four verbalization conditions to which the children were assigned were: (a) no verbalization was required (performance condition), (b) verbalization was solicited only after the selection of a positive exemplar of the concept (positive condition), (c) verbalization was solicited only after the selection of a negative exemplar of the concept (negative condition), and (d) verbalization was solicited following every selection (total verbalization condition). Under all conditions a memory aid was either present or absent.

To reduce the effects of experimenter bias, blind testing was done. All children were tested individually by one of five female testers (previously trained to administer the concept problems). The testers were graduate students in special education at New York University. The design adequately controlled most sources of internal validity: history, maturation, instrumentation, regression, selection, mortality, and the interaction of selection with the previously mentioned sources. The potential sources of external validity were not so well controlled. There is the possibility of

some reactive effects of experimental arrangements, since children were taken from the classroom for testing, but this factor is not believed to be significant.

Instrumentation and Procedures

First, the Peabody Picture Vocabulary Test (PPVT) was administered to all subjects. The purpose was to obtain a mental age to be used as a covariate in the analyses. In addition, the format of the PPVT was such that it reduced anxiety and set the tone for the rest of the testing.

Prior to the experimental trials, all subjects solved a practice problem composed of ten trials. Each trial (see Figure 1 for an example) contained four concept instances varying in five dimensions: color (green or yellow), number (two or three), form (the letter A or B), size (large or small), and black border (one or two) (a modification of the test used by McCarthy in 1968). Two-part answers were emphasized by indicating "lucky answers" such as "big B's" or "yellow A's." The tester assisted the child in understanding that choices were to be related from trial to trial. Each time a child chose a given instance, the tester asked him to look at his last choice to see whether "this lucky answer goes with the last one." After each trial the tester told the child whether or not his choice was correct by saying "Yes, that's the lucky answer." or "No, not this time. Try again." The practice trials were treated as teaching situations. Children were given as much assistance as they required to solve the task.

Insert Figure 1 about here

The experimental problems (originally designed by Bruner, Goodnow, & Austin, 1956) were modified by McCarthy (1968) for use with children.

Attributes were of five dimensions each having two values: color (red or blue), number (two or three), size (large or small), black border (one or two), and form (circle or square). Attention was called to the two values of each dimension prior to testing. To make certain that children could discriminate attributes, they were asked to name the stimuli. Any name a child used, for example, "box" for a square, was accepted and used by the tester thereafter with that child. No child was unable to discriminate attributes.

The incomplete-selection paradigm consisted of four concept instances, one positive and three negative, which were presented simultaneously at each trial (see Figure 2 for an example). There were thirty cards. The deck was used three times, thus allowing a maximum of 90 trials. Three conjunctive concepts of two attributes were presented to each child: size-dominant (small squares), color-dominant (blue circles), and number-dominant (two squares). Form was a part of every correct solution. Borders and two other attributes were irrelevant for each problem. Tests were given in a set order for all children (small squares, blue circles, two squares) in order to explore the possibility of learning. All subjects were instructed that a lucky two-part answer would win the game.

Insert Figure 2 about here

The condition in which the memory aid was present consisted of leaving the previous trial in view. A marker was placed on the child's previous choice. The tester continually reminded the child to look at his last choice.

The following instructions were given:

Now we are ready to play the real game. You will have three problems to answer. As soon as you get the lucky answer, you win. The game will stop. Each time you will point to one of these boxes: the one you think has the lucky answer in it. Try not to use too many turns to get the lucky answer. I will tell you after every turn if you picked the lucky answer. Remember that the lucky answer always has two parts.

The tester asked the child to verbalize when it was appropriate.

For the children in the condition in which the memory aid was present (assigned randomly), the following instructions were added:

To help you, I will put your last guess right here (tester demonstrates). This marker will help you remember what you choose.

After the tester told the child whether his answer was correct, the next trial was presented after five seconds to control for the postfeedback interval (Bourne, 1968). The standard interval also allowed time for the placement of the last trial in the condition in which the memory aid was present.

Demonstration that the child had attained the concept was the consecutive selection of five positive exemplars. The probability that this criterion would occur by chance alone is .0001.

Each child's verbal responses on the concept problems were taped and transcribed.

Results

Of the 146 subjects tested, 20 subjects were eliminated based on the following two criteria: a) failure to reach criterion on at least one of the three concept attainment tasks; or b) errors on the part of the tester in the elicitation of verbalization (thus invalidating a particular verbalization condition).

Table 2 presents the design with the number of cases under each

condition. Of the 126 subjects there were 32 females and 34 males in the normal group and 26 females and 34 males in the EMR group. The mental ages from the PPVT ranged from 30 months to 128 months with a mean of 80.03 (S.D. = 19.81) for the EMR group. The control group's mental ages ranged from 59 months to 216 months with a mean of 104.30 (S.D. = 29.70).

Insert Table 2 about here

The data were subjected to a multivariate analysis of covariance (MANCOVIA) with the dependent measures being concept attainment task I (CAI) small squares; concept attainment task II (CAII) blue circles; and concept attainment task III (CAIII) two squares. The independent variables were type of subject (normal or EMR), memory aid condition (present or absent), and verbalization condition (performance, positive, negative, or total). The mental age of the subjects was used as a covariate in the design.

Prior to performing a MANCOVIA, the within group correlations of the covariate with the three dependent measures were inspected in order to assess the usefulness of the covariate. The correlations were found to be as follows: CAI = $-.02$, CAII = $.02$, CAIII = $.12$. Since the correlations were neither meaningful nor significant, the covariate was dropped from further analyses.

Table 3 presents the likelihood ratio _____ and the corresponding F ratio with its associated degrees of freedom for each of the interactions in the design. All hypotheses were tested at the .05 level. Since none of the interactions were found to be significant, the interactions were pooled into the error term for subsequent tests of the main effects.

Insert Table 3 about here

The marginal means and standard deviations for the three concept-attainment across the various conditions are presented in Table 4.

Insert Table 4 about here

The tests of significance of the main effects are presented in Table 5. The multivariate test of the difference between normals and EMR was declared nonsignificant, thus upholding the first hypothesis.

Insert Table 5 about here

The second hypothesis was not supported, i.e., the multivariate test of the verbalization main effect did not reach the .05 level. Thus, there appears to be no difference in performance as a function of the kind and amount of verbalization elicited.

The multivariate test of the memory-aid main effect exceeded the critical value of .05, thus supporting the third hypothesis. Since the difference between the memory-aid conditions across the three concept attainment tasks was significant, this difference was further analyzed to determine which variables made the greatest impact. Because disagreement exists as to the procedure to be used two approaches were taken: a) an examination of the univariate F 's for the three dependent measures (Hummel & Sligo, 1971), and b) an examination of the standardized coefficients of the discriminant function (Tatsuoka, 1971).

The univariate analyses of variance for the memory-aid factor revealed that the significant difference found in the multivariate test was due primarily to the difference between the groups on CAIII. Indeed, this is the only univariate F test that was significant. Study of the means in Table 2 makes the results even clearer. The difference between the means on CAIII is 3.54, the largest absolute difference between means. In relation to the corresponding standard deviations, the mean differences on CAI and CAII are both smaller than $\frac{1}{2}$ S.D. while the mean difference on CAIII is about $\frac{1}{2}$ S.D. One-half standard deviation is analogous to effect sizes of medium magnitude found in behavioral research (Cohen, 1969).

A study of standardized coefficients of the discriminant function revealed similar findings. The coefficients were -.453, .012, and .934 for CAI, CAII, and CAIII respectively. It is clear that the greatest contribution is made by CAIII.

Discussion

As anticipated, the rate at which EMR and normal children learned the concepts did not differ. Research previously cited has suggested that differences often do not exist when mental age is controlled. It is important to note, however, that in the current study controlling for mental age did not appear to affect performance scores significantly. Perhaps the EMRs were compelled to operate at a more efficient level because the nature of the task per se required it (Clark & Thompson, 1963).

Variation of verbalization conditions lead neither to facilitation (Luria, 1961, 1963) nor hinderance (Bronckart, 1973) of problem-solving performance among either group of children.¹ A very careful analysis of the tape recordings of the experimental trials suggests that perhaps the most "pure" measure of concept learning in this study was achieved in the

performance condition when interaction between child and tester was at a minimum. Even with repeated practice and instruction, testers had extreme difficulty recognizing and controlling the use of subtle cues which might have helped the children when a particular condition was difficult for them. Aside from the performance condition, therefore, one must use extreme caution in interpreting the results of the current study. This finding in itself, however, is interesting when one wishes to extrapolate from the results of this study to possible classroom practice. It appears that many teachers may cue support, or direct children so efficiently that whether the task the child to verbalize after a correct or incorrect instance becomes unimportant. The teacher is often unaware that he uses his interaction with the child as a source of teaching-learning. Subtle variations in the teacher's phrasing and inflection may prove a rich area of further study.

Finally, both EMR and normal children profited from the presence of the memory aid. Since the superiority of the memory aid was demonstrated only on CAIII, its effect can be attributed to learning and not to teacher cueing. A step by step analysis of protocols indicated that both groups of children were initially confused by the memory aid. Many children appeared to assume that the memory aid indicated the correct answer, and not simply the instance (correct or incorrect) the child had chosen on the previous trial. The data across CA tasks suggest the possibility that the presence of the memory aid may have interfered with performance on the first task, became a neutral element in the second, and significantly affected performance on the third task when children had learned how to use it effectively. Perhaps memory aids might prove most useful as teaching-learning aids when they contain correct information.

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Footnotes

Because differences were non-significant, the intended strategy analyses were not pursued.

Table 1
Sample Differentiated by Schools

School	EMR	Normal	Total
1	19	29	48
2	15	17	32
3	16	13	29
4	20	17	37

Table 2
Number of Subjects Per Cell

	EMR		NOR	
	^a MA	NMA ^b	MA	NMA
Verbalization				
Performance	8	8	9	8
Positive	9	11	9	8
Negative	6	5	8	7
Total	5	8	8	9

Total N = 126

^aMemory Aid condition

^bNo Memory Aid condition

Table 3

Summary of Significance Tests for Interaction
Terms of Multivariate Analysis

Source	Λ	F	df
Subject Type X Memory Condition	.9694	1.1379	3/108
Subject Type X Verbalization Condition	.8965	1.3413	9/263
Memory Condition X Verbalization Condition	.9100	1.1539	9/263
Subject Type X Memory Condition X Verbalization Condition	.9069	1.1970	9/263

Table 4
Means and Standard Deviations for Main Effects

	N	CAI ^b	CAII ^c	CAIII ^d
Subject Type				
Normal	66	12.80(8.80) ^a	10.91(6.71)	11.59(8.06)
EMR	60	14.75(12.45)	16.07(13.99)	11.90(8.02)
Memory Condition				
Memory Aid	62	14.81(10.27)	12.92(9.56)	9.94(4.65)
No Memory Aid	64	12.69(11.07)	13.80(12.41)	13.48(10.01)
Verbalization Condition				
Performance	33	14.27(14.43)	11.79(8.32)	12.45(7.57)
Positive Exemplar	37	14.70(12.07)	14.73(12.29)	9.27(5.86)
Negative Exemplar	26	14.42(6.77)	13.58(14.66)	14.12(11.66)
Total	30	11.33(5.89)	13.23(8.56)	11.93(6.34)

^a Numbers in parentheses represent standard deviation.

^b Concept Attainment Task I

^c Concept Attainment Task II

^d Concept Attainment Task III

Table 5

Summary of Multivariate and Univariate Tests of
Significance for Main Effects¹

	Multivariate			Univariate <u>F</u>		
	<u>Λ</u>	<u>F</u>	<u>df</u>	CAI	CAII	CAIII
Subject Type	.944	2.33	3/118	< 1	6.74**	< 1
Memory	.932	2.87*	3/118	1.15	< 1	6.98**
Condition						
Verbalization	.918	1.15	9/287	< 1	< 1	2.35
Condition						

* $p < .05$

** $p < .01$

¹ The effect of each variables is adjusted for the effects of all other variables.

Figure Caption

Figure 1. Sample training trial of four instances on practice problem.

Figure 2. Sample trial of four instances from the concept learning tasks.



